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Agronomic Evaluation of Ozone Insensitive White Bean Varieties

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White bean (Phaseolus vulgaris L.) is among the most ozone-sensitive crops in southwestern Ontario (Ormrod et al. 1980; Linzon et al. 1984). Using ethylene diurea (EDU) as a protectant, Hofstra et al. (1978) estimated yield reductions of 32 and 36% due to ambient ozone exposure at two Ontario locations. Heritable differences in ozone sensitivity have been found among common bean cultivars (Hucl and Beversdorf 1982a,b), suggesting that development of ozone-insensitive cultivars would be one means of reducing the effect of ozone on the white bean crop.

Forty white bean breeding lines were developed from crosses between the ozone-insensitive common bean cultivars French Horticultural Bean and Gold Crop and ozone-sensitive white bean cultivars Seafarer, Ex Rico 23 and Kentwood (Hucl and Beversdorf 1982a). F_2 plants were selected visually after controlled fumigation in growth chambers for ozone insensitivity, and plants with the appropriate maturity, architecture and seed type were selected in the F_5 and F6 generation (Michaels 1988). The cultivar Midnight was included in several crosses as a source of desirable upright plant architecture. Thirty-five of these breeding lines and their parents were used in the development of a digital image analysis method for selecting ozone-insensitive white beans (Michaels 1988). Approximately 65% of the breeding lines were classified as ozone-insensitive based on visual and digital image analysis methods, as would be anticipated for germplasm subject to selection for ozone insensitivity in earlier generations.

To have lasting impact in the white bean industry, a new ozone insensitive white bean cultivar must have seed yield, maturity, disease resistance and cooking quality at least equivalent to currently available cultivars. The Ontario Field Bean Committee coordinates an annual set of White Bean Variety Trials for the purpose of testing agronomic performance of potential new cultivars. This information is used to support candidate cultivars for federal registration. We lacked the preliminary agronomic information required to determine which of these ozone-insensitive white bean lines should be entered into this trial. The objective of this study was to obtain this information by evaluating the agronomic performance and ozone sensitivity of these forty white bean breeding lines under field conditions.

Materials and Methods

Forty breeding lines and eight check varieties described previously (Michaels 1988) were planted at Woodstock, Ontario in 1987 in a randomized complete block design with three replications. Plots were 1 row, 6m long with 0.6m between rows. Seeding density was approximately 225000 plants/ha. Plots were subjectively evaluated during the first week of August for ozone sensitivity on a 1=insensitive to 5=very sensitive scale. Seed yield, days to maturity, 100 seed weight and harvestability were also determined. The latter is a subjective evaluation of the potential harvest losses under

direct combine harvest with 1=no losses and 5=severe losses. Seed yield was adjusted to the industry standard of 18% moisture. Seven of the best breeding lines were subsequently entered into advanced yield trials at Elora and Woodstock in 1988.

Results and Discussion

The late maturing check cultivars Midnight, Steuben Yellow Eye and Fleetwood had the lowest ozone injury (Table 1). Low injury of these cultivars in field conditions may be associated with their late maturity and avoidance of the ozone exposure during a particularly sensitive growth stage such as flowering and early pod filling. In contrast, Gold Crop and French Horticultural Bean, which were used as donors of ozone insensitivity, appeared sensitive in this field trial. Eighteen breeding lines showed low levels of sensitivity with scores of 2.7 or lower.

Two of the breeding lines, W02885 and W04885, were significantly higher yielding than the highest yielding white bean check cultivar, Ex Rico 23. Both of these lines were at least 4 days later maturing, however. Since cultivars that are later maturing than Ex Rico 23 are generally undesirable, these lines may be of only limited importance. Twenty-seven lines were not significantly different from Ex Rico 23 in yield. From this group, several lines with favorable combinations of ozone sensitivity, maturity, yield and seed size were be identified. Line W02785, for instance, had an ozone injury score of 2.7, yielded numerically greater than Ex Rico 23 with the same number of days to maturity. This line also had high levels of ozone-insensitivity in a controlled fumigation study (Michaels 1988).

Seven of these breeding lines (W01985, W02185, W02285, W02585, W02785, W02885 and W04885) were entered in advanced yield trials in 1988 at Woodstock and Elora. Preliminary data from the Elora site indicated that all of the lines were late maturing and exhibited potentially undesirably high levels of vining. Lines W02585, W02785 and W04885 again showed desirable levels of ozone-insensitivity. Yield data from these sites are not yet available. A breeding line will be chosen from among this group for entry into the 1989 White Bean Variety Trials based on the final data from the two trials in 1988.

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Table 1 Agronomic performance of ozone-insensitive breeding lines and check cultivars, Woodstock 1987.

Entry		Ozone Injury†	100 seed wt.	Maturity	Harvestability‡	Yield
			g	days		kg/ha
SEAFORTH		4.3	19.6	88	5.0	2455
EX RICO 23		3.0	22.1	104	4.7	3002
KENTWOOD		3.3	24.2	96	4.0	2466
MIDNIGHT		1.7	20.3	107	3.7	4227
GOLD CROP		4.0	32.8	97	4.0	1247
FRENCH HORT.		4.0	51.1	93	3.7	1982
FLEETWOOD		1.0	20.3	108	5.0	2866
STEUBEN Y.E.		1.3	50.3	105	5.0	2231
W80-4	W00285	2.3	20.3	107	5.0	2919
W80-4	W00385	2.3	23.9	107	4.3	3142
W80-4	W00485	2.7	20.4	107	4.7	2905
W80-4	W00685	3.3	20.3	106	4.3	3010
W80-5	W00785	3.3	20.1	107	4.7	2253
W80-5	W00885	3.0	20.3	105	4.3	2410
W80-5	W01185	3.3	20.7	103	4.3	2943
W80-6	W01585	2.7	21.2	105	5.0	3095
W80-6	W01685	3.7	21.6	107	4.7	3147
W80-6	W01785	2.7	20.5	106	4.3	3212
W80-20	W01885	3.3	17.9	105	5.0	2894
W80-20	W01985	3.0	18.3	108	4.3	3176
W80-20	W02085	2.7	17.8	100	4.7	2951
W80-20	W02185	3.0	18.8	107	5.0	3577
W80-20	W02285	2.7	18.7	107	5.0	3189
W80-20	W02485	3.3	19.5	105	5.0	3241
W80-20	W02585	2.7	18.1	106	4.3	3529
W80-20	W02685	3.7	18.0	98	5.0	2954
W80-20	W02785	2.7	19.2	104	5.0	3345
W80-20	W02885	2.3	18.0	108	4.0	3666
W81-4	W02985	4.0	27.7	96	4.0	1505
W81-4	W03085	2.7	19.1	104	5.0	2085
W81-4	W03185	4.0	19.7	101	4.7	1701
W81-12	W03685	3.0	25.6	108	4.0	2745
W81-12	W04485	2.3	27.0	106	4.3	2080
W81-12	W04685	3.7	24.6	97	4.0	2506
W81-12	W04785	3.3	24.9	91	5.0	2789
W81-12	W04885	2.3	22.0	109	4.7	3618
W81-12	W04985	3.0	23.7	96	4.3	2704
W81-12	W05285	3.7	24.4	98	3.7	2253
W81-12	W05485	2.0	25.6	103	4.7	2258
W81-17	W05585	3.0	24.1	96	4.7	2373
W81-17	W05685	2.7	26.3	96	4.0	2530
W81-25	W06385	4.0	22.6	88	3.3	2494
W81-25	W06685	4.7	22.2	88	4.0	2454
W81-25	W06985	4.0	22.1	87	3.3	2476
W81-41	W07585	2.7	20.9	105	4.3	1217
W81-41	W07885	1.7	22.4	103	5.0	1291
W81-41	W08185	2.3	26.1	105	4.7	1667
W81-54	W08385	2.0	24.8	106	4.0	2395
LSD 0.05						591

† 1 = insensitive, 5 = very insensitive
‡ 1 = no harvest losses expected 5 = severe harvest losses expected